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Cover

Inflated Platform for Discovery—Under West Texas skies, a NASA-sponsored heavy lift balloon nears the final inflation stage before launch. The NASA Balloon Program, managed by the Wallops Flight Center, recently climaxed two years of work in high energy astrophysics, astronomy and upper atmospheric research with an important scientific discovery. A team from New Mexico State University, using a NASA/Wallops high altitude balloon carrying ultrasensitive instruments, found small amounts of antimatter in our galaxy (The Milky Way) in the form of antiprotons. Antimatter has the same characteristics as matter except that its electrons and protons have the opposite electrical charges. The observation was made at an altitude of 34 km over Texas in one of the approximately 120 balloon missions flown by Wallops.

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Wrong Wire Causes Test Failure

The failure of a hydrogen line on the nozzle of a Space Shuttle main engine is attributed to use of improper welding wire. The failure occurred Nov. 4 during an automatic shutdown of a three-engine cluster of test engines at NASA's National Space Technology Laboratories in Bay St. Louis, Miss.

Use of the improper welding wire severely decreased the strength of the weld on a segment of hydrogen line known as the "steerhorn," near the base of the engine nozzle. When the line ruptured an oxygen-rich combustion resulted, extensively damaging the test engine. Two lots of welding wire, designated Inconel 718, are suspect. Investigation of the lots revealed about 20 percent was a weaker weld wire, Inconel 600.

Investigators from Marshall Space Flight Center and Rockwell International's Rocketdyne Division, Canoga Park, Calif., will check all steerhorn welds to determine the possible extent of use of the suspect wire and determine what steps are needed to correct the problem, which NASA noted is *not* in the engine design. Weak welds can easily be detected by an oxalic acid etch test.

Main propulsion system testing resumed successfully on Dec. 17. A stub nozzle, used in previous three-engine cluster tests, was substituted for the engine nozzle used in the Nov. 4 test.

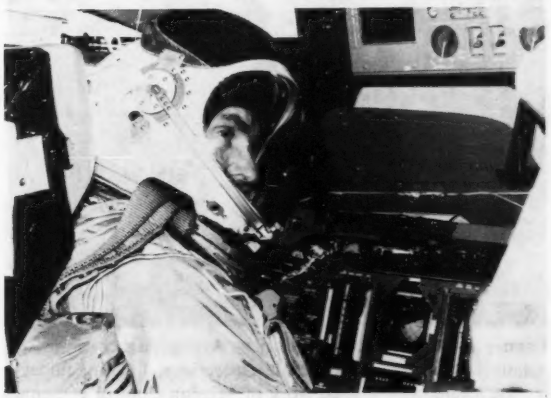
Shuttle Schedule As Amended

On Nov. 14, Dr. Robert A. Frosch met with President Carter to discuss the Space Shuttle and its problems—financial, managerial and technical. According to Frosch, the hour long meeting resulted in a "Presidential vote of confidence". Later in the day, at a Headquarters press conference, Dr. Frosch gave a highly tentative Shuttle timetable:

"The key points are that the orbiter must complete its manufacture and checkout, the solid motor must have its fourth test, the external tank is about to complete its certification, the orbiter systems are about three-quarters of the way through certification.

"We would then hope to bring the orbiter out and mate it with the stacked solid motors and external tank around March; then take it to the pad for launch preparation, that is to say put it on the pad and go through the complete set of electrical, electronic and mechanical checkout prior to launch; some time in May have a test firing, a flight readiness firing, which would be a short firing to check the liquid engines and all systems but not firing the solid rocket boosters; depending on how successful that was, then be able to proceed to launch as early as the end of June. We would say now, I think, that while June is a possible launch date, some time in August, September is a much more likely launch date and what we think most likely to happen, although we are working to June as a schedule matter. It looks as though the principal remaining problems have to do with the certification through testing of the main engine

Contingency Check at KSC—Space Shuttle Astronauts Richard Truly (left) and Joe Engle leave the Orbiter Processing Facility at the Kennedy Space Center after completing escape suit testing. The tests were conducted in the cabin of the orbiter Columbia to make certain that escape suit fittings and harnesses were compatible with the spacecraft ejection seats.



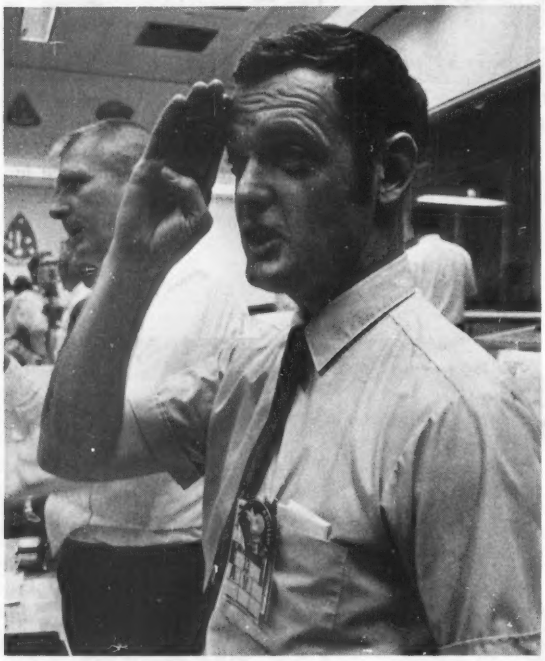
Left Seat Checkout—Astronaut Joe Engle, an Air Force colonel and veteran of the 1977 Space Shuttle approach and landing tests, monitors instruments from the command pilot's seat during ejection escape suite testing in the orbiter.

systems. My earlier statement applies to that, namely we are having odds and ends of problems, but in a complex system like that engine, all those problems must be cleared up and each such problem leads to some kind of time in order to do that.

"The other comment that the President made with regard to the approach to flight is that as we get close to the flight, he would like to be kept informed of any significant points of progress, change, or difficulty, and that I am to do that either in the normal ways, or if necessary in my judgment, to talk with him directly and personally."

Acting Head of Shuttle Operations Named

Glynn S. Lunney, manager of the Shuttle Payload and Integration Development program at the NASA Johnson Space Center has been named Acting Associate Administrator for Space Transportation System Operations at NASA Headquarters, effective immediately. Lunney, who reports to Deputy Administrator Dr. Alan M. Lovelace, will be instrumental in forming the new office which was established as a result of the recent decision to separate Space Transportation System Acquisition from Operations. He will continue in the assignment until the position of Associate Administrator for STS Operations is filled.



Lunney in Apollo Days—The new Acting Associate Administrator for Space Shuttle Operations, Glynn Lunney, is shown saluting the good work of Mission Control personnel after the successful recovery of the Apollo 13 crew in 1970. A Flight Director at the time, he was later U.S. Technical Director for the Apollo-Soyuz Test Project and more recently, manager of Shuttle Payload and Integration.

Lunney joined NASA in 1959 at the agency's Lewis Research Center; He was part of the Space Task Group at Langley Research Center, Hampton, Va., and moved with that group to Houston when the Manned Spacecraft Center was created. He was a flight director during the Gemini and Apollo manned flight programs and was U.S. Technical Director for the Apollo Soyuz Test Project joint manned mission with the Soviet Union in 1975. Lunney also spent a year at NASA Headquarters in 1976–77 as Deputy Associate Administrator for Space Flight.

Launch the 150th for Delta

The 150th launch of the Delta rocket placed a domestic communications satellite in Earth orbit in early December. The milestone launch by the "workhorse" of NASA's stable of expendable launch vehicles was, fittingly, the last of the decade. Dating back to May 1960, 137 of 149 Delta launches have been successful, a 92 percent success record.

The RCA American Communications 24-channel SATCOM 3 is now missing. It was to have provided television, voice communications and high-speed data transmissions to all 50 states, primarily to serve the cable TV industry. The Delta 3914 launch vehicle boosted the 895-kilogram spacecraft into an elliptical transfer orbit ranging in altitude from 167 kilometers to 35,786 km.

Approximately three days after launch, an apogee kick motor aboard the satellite was fired and the spacecraft was to have entered a geosynchronous orbit 35,786 km above the equator. At this point, it disappeared from the RCA tracking screens, touching off an exhaustive search of near-Earth space.

The Delta project is managed by Goddard Space Flight Center for NASA's Office of Space Transportation System Operations in Washington, The RCA SATCOM system is managed by RCA American Communications, Inc. Launch operations were conducted by the Kennedy Space Center with all launch costs reimbursed by RCA American. RCA Astro-Electronics Division, Princeton, N.J., built the satellite. McDonnell Douglas Co., Huntington Beach, Cal., is prime contractor for the Delta launch vehicle.

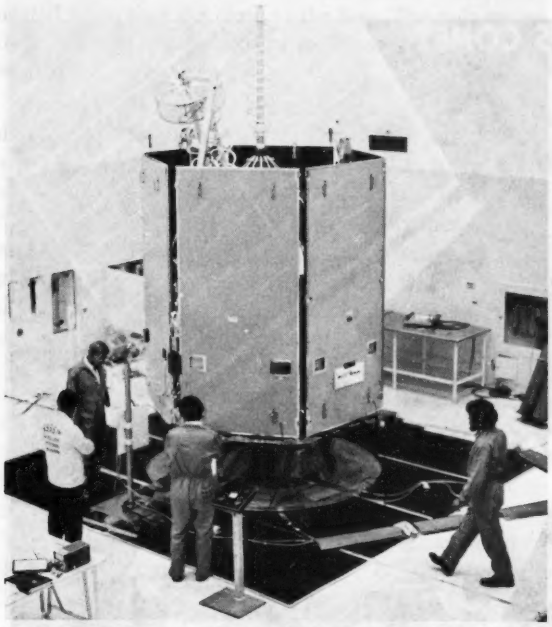
FLTSATCOM Launch Rescheduled

Launch of a FLTSATCOM communications satellite, scheduled for Dec. 4, aboard a NASA Atlas Centaur from Cape Canaveral has been rescheduled for no earlier than Jan. 17.

The delay was prompted by a leak that developed in the high pressure pneumatics system of the Atlas. The leak, detected during routine testing, was traced to a cracked sleeve and nut assembly. The defective sleeve and its associated parts and tubing were removed and replaced. The launch delay has no operational impact on the FLTSATCOM program or service of its Department of Defense users.

Analysis of the sleeve disclosed that it was manufactured from stainless steel which did not meet specifications. An immediate investigation was conducted on all other ⅝-inch sleeves on the launch vehicle and changes were made where necessary.

Additional investigation has revealed that the problem is more widespread. Other size sleeves have been located in stock that do not meet specifications. A detailed plan has been formulated to investigate all appropriate fittings on the launch vehicle.



Destination: Western Pacific—The FLTSATCOM communications satellite is checked over on its way to becoming the third in a Department of Defense series. Launch of the FLTSATCOM, slated for a geostationary orbit over the Pacific Ocean, was delayed in December by technical problems with the launch vehicle. The spacecraft has a design life of five years.

New Thrust in Space Communications

A new, five-year development effort aimed at retaining U.S. world leadership in satellite communications research and technology has been initiated by NASA with lead responsibility for the program assigned to its Lewis Research Center in Cleveland. Lewis will work closely with private industry, the Department of Defense and other NASA Centers on projects which could culminate in the development and launch of a sophisticated communications satellite in 1985 or 1986.

General objective of the program is to spur more effective and increased use of the radio frequency spectrum at the geostationary orbit level, approximately 35,900 kilometers above the Earth.

Another major goal is to develop technology that will provide for lower space communications service costs and catalyze new and innovative services for the public good. An example of the latter would be high-speed, electronic mail services.

Advanced technical studies, already underway at Lewis in support of the new program, are focusing on feasibility of high-technology satellites employing multi-beam antennas, on-board signal processing and switching, high-power transmitters using both solid state and traveling wave tube amplifiers, and solid state low-noise amplifiers. From these studies may emerge a space communications system with the capability of pinpointing transmissions almost anywhere in the country regardless of population size or electronic sophistication.

The Communications Technology Satellite, a joint effort of the United States and Canada, was a Lewis-managed program (for the U.S. portion) which kept the center active in communications technology during a period after 1973 when NASA was withdrawing from communications research and development.

The U.S.-Canadian satellite provided more than three years of space communications experimentation in the use of interactive color television, voice and data transmissions for a host of educational, business, medical and public service programs.

"NASA had phased down its satellite communications technology work in 1973 because of budget pressures and the strong capabilities present in the

private sector," explained Daniel J. Shramo, Lewis Director of Space Applications.

"In the intervening years, the communications industry made exemplary progress in advancing the state of the art. The improvements included increasing the number of circuits per satellite, decreasing satellite weight per channel and improvements in antenna performance.

"In 1978 a number of activities were conducted to determine whether NASA should re-enter satellite communications R & D. NASA itself intensively reviewed the state of technology in satellite communications, investigating possible areas where federal assistance would sustain perceived growth expectations.

"After a number of NASA centers had prepared independent assessments, an inter-center team developed a five-year action plan which was subsequently reviewed with major corporations dealing in communications systems and services, with NASA advisory committees and with related other government agencies. All of the re-examination led to the Lewis assignment to assume the lead NASA role in a new effort."

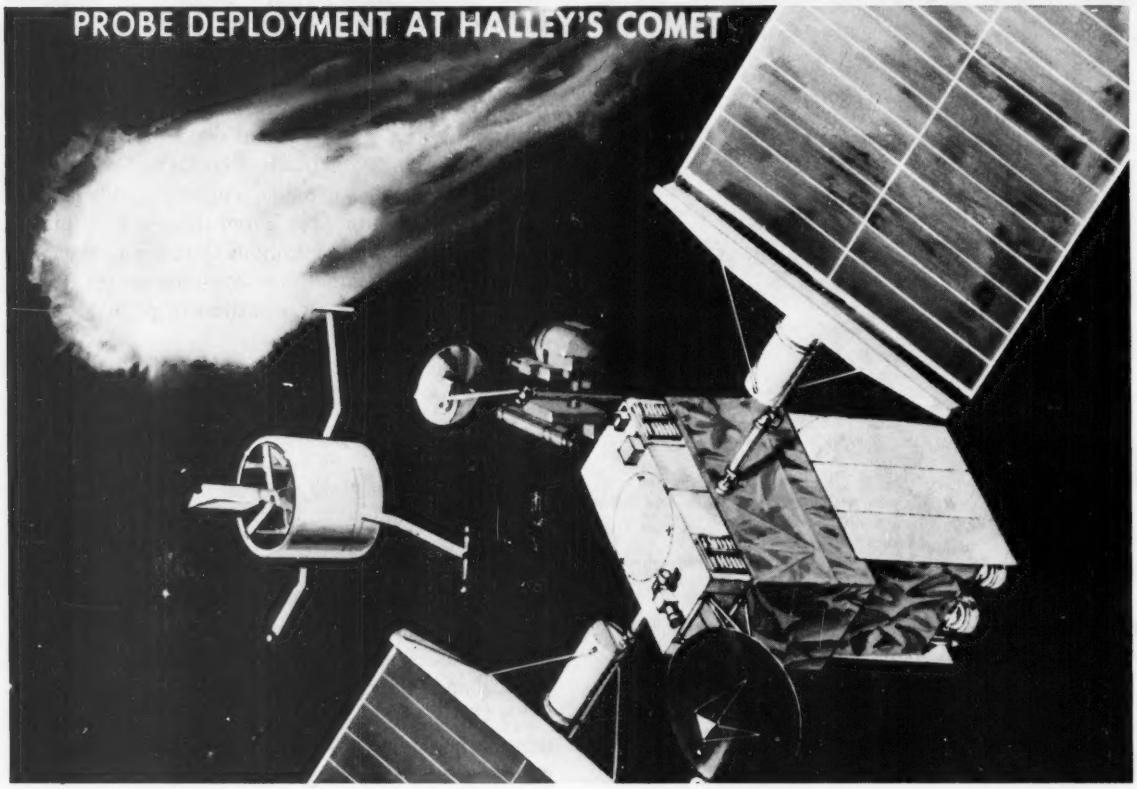
Journey to Two Comets

In cooperation with the European Space Agency, NASA is asking scientists to propose experiments for a planned international mission to two comets—Halley and Tempel 2, the total journey to span four years and cover more than 2.5 billion kilometers.

Utilizing solar electric propu'sion engines for the first time in deep space, the spacecraft would fly past Halley's Comet in 1985, release an instrumented probe toward the comet and then go on to encounter Tempel 2 in 1988 and fly side by side with it for a year or more as Tempel 2 circles past the Sun.

Closeup pictures and other scientific information returned by the spacecraft could add significantly to our knowledge about comets, which in túrn may shed more light on the origin and evolution of the solar system.

NASA emphasized that the project has not yet been approved but that early selection of scientific participants and investigations is required for a prompt start if approval is granted. Under current plans, NASA will be responsible for the launching, rendezvous spacecraft system and mission operations.



The European Space Agency, a consortium of 11 nations, will be responsible for the Halley probe system. The combined scientific payload will be shared by scientists throughout the world.

The proposed mission has three major science objectives:

- To determine the chemical and physical nature of the comet's nuclei.
- To characterize the chemical and physical nature of the comas, the gases and dust which surround the nuclei when the comets approach the Sun.
- And to determine the nature of the comets' tails.

Instruments on the Halley probe and the rendezvous spacecraft will sense the comets remotely as well as collect dust and gases for onboard analysis.

Comets are relatively small bodies circling the Sun in orbits of widely different periods and distances. They are believed to be composed of loose mixtures of water ice, frozen methane, ammonia, carbon dioxide and other gases, with bits of cosmic dust, rock and sand. The combined nucleus and coma make up the head of the comet, which may grow from 2,000 to 200,000 km or more across as it approaches the Sun. Comets grow tails of dust and gases as they are heated when they get close to the Sun. The tails range from millions to hundreds of millions of miles in length.

The opportunity to make close visits to two different types of comets is ideal for the scientists who are trying to understand these "mavericks of the solar system." Because comets spend most of their time far from the Sun—in a very cold corner of the solar system—their original material is believed to be preserved as if it were in a deep freeze. By sampling this material, scientists hope to unlock some of the secrets surrounding the formation of the solar system.

Since comets can be quite different in their chemical and physical characteristics, it is important to sample more than one type. Among large highly active comets which display the full range of phenomena, only Halley has a predictable orbit. It will make its once-every-76-years appearance during the winter of 1985–86. Accordingly, the mission contemplates a flyby of this comet which will not be seen again until 2061.

Unlike Halley, Tempel 2 is smaller and relatively stable. It is typical of a class of comets known as short-period comets which are easier to visit by a spacecraft but exhibit less active phenomena.

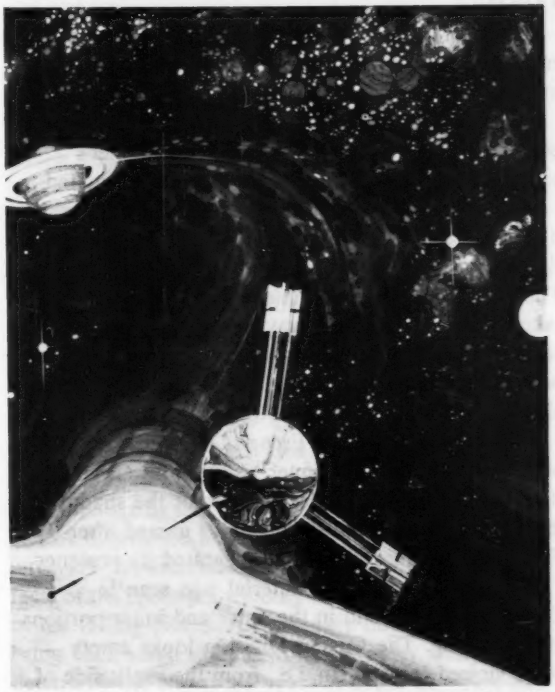
The Halley/Tempel 2 comet mission would be launched by a Space Shuttle in July 1985, with the spacecraft propelled in deep space by ion (solar electric) propulsion, a new fuel-efficient technology system now under development by NASA.

If approved, the Jet Propulsion Laboratory, will manage the mission for NASA's Office of Space Science. JPL also will be responsible for a rendezvous spacecraft system and mission operation. A European Space Agency project team will be responsible for the Halley probe. The design, development and implementation of the mission will involve the direct interaction of NASA and the European project teams and a Project Science Group composed of principal investigators, team leaders and selected interdisciplinary scientists.

Pioneer Saturn Results Summarized

NASA's Pioneer 11 spacecraft continues to work well after successfully flying past Saturn, the most distant planet yet reached in U.S. exploration of the solar system.

The space probe is now heading out of the solar system after returning the first closeup pictures of



Beginning of Pioneer 11's Odyssey—An artist's conception of the start of Pioneer 11 toward its five-year journey to ringed Saturn after flying past the planet Jupiter in December 1974. The Pioneer space probe is now leaving the solar system after obtaining pictures of Saturn and surviving the flight under its visible rings.

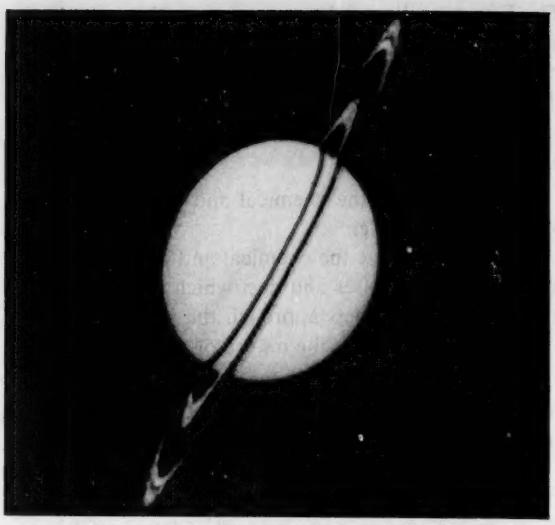
Saturn and making a number of important scientific findings, including the discovery of two new outer rings and possibly a new Saturnian moon. In addition, Pioneer sustained no damage from high-velocity ring particles showing that spacecraft can operate safely in the vicinity of the visible rings.

After a six-year trip of more than 3.2 billion kilometers in space, Pioneer spent 10 days photographing and measuring the ringed planet. As it made its closest approach, Sept. 1, to within 20,800 km of Saturn's cloud tops at a speed of 114,500 km/hr some 1.6 billion km from Earth, Saturn's gravity swung it almost 90 degrees on a change of course toward the edge of the solar system.

Without a failure, Pioneer can return useful data until the late 1980's, when it reaches the limit of its radio contact with Earth.

Major findings about Saturn are:

- Saturn has an 11th moon. It was discovered in a photo taken of the outer edge of Saturn's rings and by instrumentation on board the spacecraft. Its estimated diameter is 400 km. It has been named 1979S1.
- Saturn has a magnetic field, magnetosphere and radiation belts. It joins Earth and Jupiter as a magnetic planet.
- Because of the low temperature measurements, evidence for the possibility of life on the planet's satellite Titan was discouraging, but not eliminated.
- Two new rings have been identified. One, which has been called the F ring, is separated from the A ring by a 3,600 km gap, called the Pioneer division. The F ring was clearly visible in a closeup picture taken some 943,000 km away from the planet. A second ring, the G ring, also was discovered and lies between the orbits of the satellites Rhea and Titan or about 500,000 km from the cloud tops.
- A feature called the French Division, a division between the middle and inner visible rings (B and C rings), was seen in Pioneer pictures of the shadow of the rings on Saturn's surface. It was named after French astronomers who first suggested its presence.
- Substantial particle material was seen in Cassini's Division and in the outer and inner portions of the A ring. The Cassini Division looks empty when viewed from Earth, i.e., from the sunlit side of the rings.
- The B ring was found to be so opaque that it allowed almost no light to pass through it.
- The C ring was found to have few particles and appeared as diffuse as Cassini's Division.



Saturnian Portrait—Scientists say this is the best view yet available of Saturn with its rings, returned by the Pioneer spacecraft during its encounter in August. The picture was taken 58 hours before closest approach and has undergone extensive computer processing to bring out detail.

- Pioneer found no evidence of either an innermost D ring or the expected outer E ring.
- Preliminary measurements of the ring mass indicate they have a low density. This suggests they are made up largely of ice.
- A substantial glow of atomic hydrogen was found around the rings which suggests absorption of protons from the radiation belts caused dissociation of water ice in the rings.
- Pioneer sustained two meteoroid hits above the rings and three more hits below the rings.
- Gravity field measurements indicate that Saturn is flattened about 10 percent at the poles by its rapid rotation and is not an oval body. It has a depression at midlatitudes of about 120 km.
- Gravity field analysis and temperature profile measurements suggest that the planet's core, extending out about 13,800 km from the center, is about twice the size of the Earth, but is so compressed by Saturn's huge mass that it contains about 11 Earth masses of material, largely iron and rock.
- Above the core, out about another 21,000 km the measurements suggest that the planet consists of liquid metallic hydrogen, which does not exist on Earth. The presence of liquid metallic hydrogen is supported by the discovery that the planet has a magnetic field. To produce this field, a planet needs fast rotation and a liquid electrical conductor in its interior—in Saturn's case, liquid metallic hydrogen.

• Two and half times more heat is radiated into space by Saturn than is absorbed from the Sun. One interpretation of this observation is that perhaps only a third of Saturn's heat is generated by leftover heat of planet formation and by continuing gravitational contraction, with most heat being generated by denser helium sinking through the planet's liquid hydrogen interior. The upper atmosphere was determined to be 5 C (41 F.) warmer than expected.

• Saturn's magnetic field is 1,000 times stronger than Earth's and 20 times weaker than Jupiter's. The field is unique because its north-south axis lines up with Saturn's rotation axis, unlike the 10 degree tilt to the rotation axis of Earth, Jupiter and the Sun.

• Saturn has a magnetosphere, a magnetic "bubble" in the solar wind which surrounds Saturn, which is larger than Earth's, but smaller than Jupiter's. The nose of the teardrop-shaped magnetic envelope is usually about 1,250,000 km from the planet. Its width is about 3,400,000 km.

• The planet has radiation belts made up of high energy electrons and protons which are comparable in intensity to those of the Earth, although the region they occupy is about 10 times larger. They are several hundred times weaker than Jupiter's.

• The radiation belts are completely eliminated by Saturn's rings because their high energy particles mirror back and forth between Saturn's poles about once a second, finally striking ring material which absorbs them. This is the most radiation-free sector of space yet found in the solar system.

• The moons Janus, Enceladus and Tethys also absorb large numbers of radiation belt particles.

• Closeup pictures showed Saturn's cloud tops, unlike Jupiter's, have few details.

• Saturn's cloud tops appear to be lower at the poles than at the equator. As a result polar clouds were seen ranging from dark blue to slightly green and changing to brownish belts around 55 degrees latitude.

• There appear to be jet streams around 70 degrees latitude and overall the planet appears to have more and narrower belts and zones than Jupiter.

• Infrared instrumentation showed the equatorial zone cooler than adjoining higher latitude regions and clouds of this zone are, therefore, probably higher. This suggests height and temperature differences between the belts and zones as expected.

• Ultraviolet instrumentation may have detected a generalized hydrogen glow or the presence of auroras on Saturn.

• Titan was found to have a cloud top temperature of −198 C (−324 F.). This very cold temperature eliminates an internal heat source as a means of warming Titan's surface, but leaves the possibility of atmospheric heating from a greenhouse effect.

• Light from Titan was found to be strongly polarized which is expected to allow determination of the kinds of aerosols or particles believed to be in the satellite's atmosphere.

• The ultraviolet instrument found a hydrogen cloud around Titan. This suggests its methane atmosphere is slowly breaking down into hydrogen and carbon, with the hydrogen escaping into space and carbon-based aerosols falling to the surface.

• Pioneer measurements are providing an improved mass and diameter for Titan. These measurements are expected to provide a density determination and estimates of its interior. Its density is believed to be low enough for it to contain significant quantities of interior ice.

• Titan has a magnetic wake within Saturn's magnetosphere. It extends ahead of the satellite instead of behind it, because of the planet's fast magnetosphere rotation.

The Pioneer program is directed by the Office of Space Science, NASA Headquarters. Project management is the responsibility of Ames Research Center. The spacecraft was built by TRW Systems, Redondo Beach, Cal.

Skylab Debris Finders Recognized

The National Aeronautics and Space Administration has prepared personalized plaques for 20 Australian citizens who provided the agency with debris they had gathered from the Skylab space station, which returned to Earth over the Indian Ocean and Western Australia July 11. A fragment of the Skylab material provided by the individual is attached to each plaque.

Soon after Skylab fell, without damage or injury, NASA dispatched a small group to Australia to interview eyewitnesses and otherwise determine the facts of the reentry, including the pattern of dispersion of the falling pieces. A secondary objective was to bring back small samples for laboratory analysis to determine the effects six years of space exposure had had on certain materials. Citizens who voluntarily surrendered pieces of the debris were assured they would be returned.

The plaques express the appreciation of NASA for the assistance rendered by the finders. They are

Skylab Souvenirs Sent Back—Dr. W. R. Lucas (R), director of Marshall Space Flight Center, and James E. Kingsbury, Science and Engineering director, examine the plaques mailed to Australian finders of Skylab debris. Attached to each plaque is a fragment of Skylab material, loaned to the Marshall center for study, and an expression of thanks by the space agency for assistance rendered by individual Australians.

signed by Dr. William R. Lucas, director of Marshall Space Flight Center, where the material was analyzed and the plaques were made.

Of the 22 specimens brought to Marshall by the center employees who returned from Australia in late July, 20 were determined to be from the Skylab. Analysis of the debris showed that all materials performed well, attesting to the soundness of the space station design. In some cases they performed well beyond expectations.

Laboratory study also indicated that Skylab did not experience reentry heating quite as high as had been predicted. The space station's reentry disintegration began at an altitude about 19 kilometers lower than had been expected, resulting in a "footprint" or area of debris distribution much smaller than anticipated; about 74 km wide and 4,400 km long, compared to the expected 185 by 7,400 km.

Residents of thinly-populated Western Australia continue to find and report pieces of the spacecraft. In late October, the State Emergency Services Group at Esperance sent photographs and descriptions of five small pieces that had been found. Earlier, a Perth writer who was on a Skylab "safari" found a large piece of aluminum weighing 80 kilograms near Balladonia. It has been determined that the aluminum most likely is a door from the film vault in the Skylab workshop.

Another significant "find" after the American group left Australia was a pair of titanium spheres which held nitrogen. They were near Rawlinna, in the area where two large oxygen tanks were found earlier. Although no hardware finds have been reported farther north (downrange) than Rawlinna, NASA authorities reason that several pieces have yet to be discovered within a few hundred kilometers of Rawlinna, the footprint ending at 26 degrees south and 131 degrees east, about 926 km northeast of Rawlinna.

Heavier Skylab elements not yet found include the orbital workshop film vault, and portions of the solar observatory, including the structure. control moment gyros and Experiment S054.

Pilot-Aid System for Small Airports

Flight demonstrations are being conducted by NASA of an experimental Automated Pilot Advisory System which broadcasts airport and air traffic advisory messages, using a computer-generated voice technique. The system automatically tracks aircraft within three miles of an uncontrolled airport and issues messages on air traffic location and heading. Uncontrolled airports are small, general aviation airports. Airport wind, barometric pressure, temperature and active-runway messages also are broadcast by the system.

Major objectives of the automated system are to:

- Broadcast airport advisory information at least once every two minutes.
- Broadcast air traffic advisory information at least once every 20 seconds.
- Broadcast collision warnings when required.

The technology being demonstrated at Wallops Flight Center has application to high-density uncontrolled airports where more than half of midair collisions occur. Accident factors include failure to see other aircraft and take evasive action, traffic pattern flow errors and the lack of communications. The technology also could find application as a possible shift-reliever at controlled airports (large air terminals).

Principal elements of the experimental system are a radar set, a mini- and a micro-computer, weather sensors and a very high frequency transmitter. The computers provide radar detection and target tracking, evaluation of weather sensor data and generation of the several audio voice messages for transmission to arriving or departing aircraft.

The program will attempt to optimize these techniques and to determine the feasibility of a

low-cost radar and computer to achieve an automatic system tailored for the high-density, uncontrolled airport environment. NASA and the Federal Aviation Administration have established a cooperative program to insure compatibility of the system with an Automated Terminal Service project underway at the aviation agency. NASA is assisting in specifying the technical requirements and relative benefits of both the advisory system and the terminal service project.

The Wallops project manager is John L. Parks, Jr. Project coordinator is Gene Godwin and Loyd C. Parker is the principal investigator.

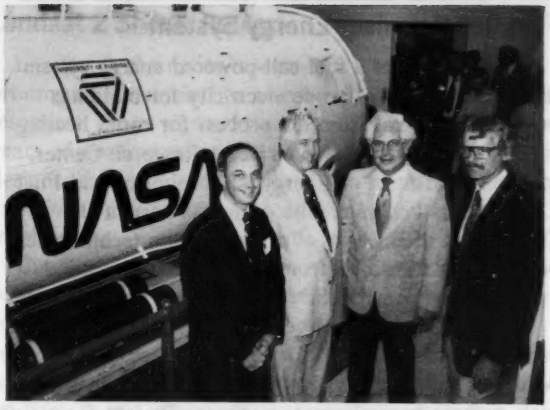
Apollo Facility Benefits Florida

A Kennedy Space Center hyperbaric chamber originally designed for emergency treatment of Project Apollo astronauts involved in high altitude spacecraft testing has embarked upon a new career in research, medical education and patient treatment at the University of Florida's Shands Teaching Hospital in Gainesville.

A hyperbaric chamber is a specially equipped pressure vessel that can be used to administer air or oxygen at greater than atmospheric pressure. The chamber was originally obtained for treatment of Apollo astronauts if decompression sickness—"the bends"—should occur during their training in altitude tests of the Apollo spacecraft.

No immediate requirement for the chamber existed at KSC after the conclusion of the Apollo program and Dr. Paul Buchanan, director of KSC's Biomedical Office, was instrumental in arranging its long-term loan to the Shands Teaching Hospital. The NASA/KSC unit has become the focal point of the hospital's Jerome Johns Hyperbaric Facility, named for the Starke, Florida, businessman who was instrumental in the chamber's transfer.

Skin diving is a popular recreation in Florida and "bends" cases resulting from divers surfacing too rapidly are not uncommon. The KSC chamber now in Gainesville is one of only four in the state able to treat with a pressure equivalent of 165 feet underwater (the others are located in Miami, Panama City and West Palm Beach). In addition, the chamber can treat three patients at once and is one of only a handful in the country which can be operated as a self-contained intensive care unit.



KSC Hyperbaric Chamber Dedicated—From left are Dr. William B. Deal, vice president for health affairs, University of Florida; Jerome Johns, after whom the facility was named; Dr. Jerome Modell, professor at the University of Florida College of Medicine, and Dr. Paul Buchanan of Kennedy Space Center's Biomedical Office.

A special building to house the chamber was built at a cost of $115,000 in state funds and skindiving groups contributed nearly $15,000 to the facility. The chamber was moved into its new building in January, 1979. After final construction adjustments and training of personnel in use of the chamber, the first patient was treated in July, 1979.

Eight patients received treatment between July and the facility's dedication in early November and hospital officials foresee up to 200 chamber runs per year in the near future. Diseases or conditions in addition to the "bends" responding to hyperbaric treatment include certain types of strokes, gas gangrene, severe blood loss anemia, carbon monoxide and cyanide poisoning, chronic bone infection, burns, and spinal cord trauma. Hyperbaric treatment has also been shown to be helpful in improving the survival of compromised skin grafts.

For a number of years, Shands had used a single-person hyperbaric chamber about the size of an iron lung. Once the patient was sealed inside the chamber, medical personnel had no means of providing treatment or other care. In the new chamber, there is room for one or more attendants and a physician can be "locked" in and out if necessary.

"We had no immediate mission at KSC for the chamber and lacked the funds and facilities to operate it," commented Dr. Buchanan. "This example of state and federal government cooperation has established a valuable treatment and research facility. I guess it would be fair to regard it as another very useful public benefit from Project Apollo."

Fuel Cell Promises Energy System

Development of a fuel cell-powered energy system that will not only generate electricity for buildings but use waste heat from the process for room heating is being managed by NASA's Lewis Research Center, for the Department of Energy's Phosphoric Acid Fuel Cell Systems Program. The project is part of the Department of Energy's effort to develop technologies permitting a transition from petroleum and natural gas to alternate, synthetic fuel sources.

In operation, the fuel cell electrochemically combines hydrogen and oxygen to produce electricity. A fuel conditioning system produces hydrogen from fuels such as natural gas or naphtha. Oxygen is supplied from the air. In the future, hydrogen could be obtained from synthetic liquid or gaseous fuels.

Fuel cell configurations and fuel processors will be developed in the NASA Lewis project and designs established for a 30-kilowatt fuel cell and 60-kilowatt fuel conditioner. The overall system will be so efficient that the amount of fuel normally required to heat a home or apartment would also provide 40 percent of the electrical needs.

Follow-on work is expected to lead to a 120-kilowatt integrated energy system that will meet all the heating, cooling and electrical needs of an apartment complex or a small shopping center with much higher efficiency than is possible with conventional systems.

Westinghouse Electric Corp. Research and Development Division, Pittsburgh, as the prime contractor, is responsible for overall system integration and analysis, the fuel conditioner and the heat recovery subsystems. Energy Research Corp., Danbury, Conn., the major subcontractor, has responsibility for the fuel cell development. Work will be performed at the contractors' plants in Pittsburgh and Danbury.

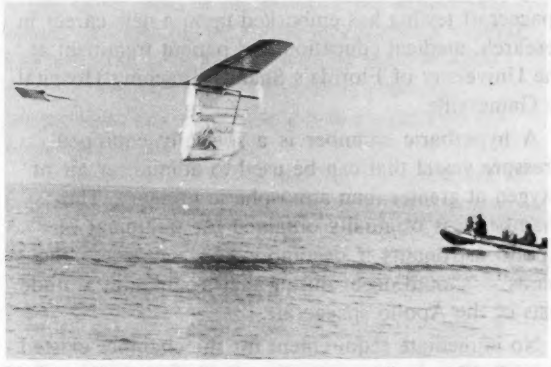
The two-year $4,400,000 Westinghouse contract, calling for design, test and analysis of key components of the system, will lead to installation in the mid-1980s of experimental systems at several sites in the United States.

Gossamer Albatross to Fly For NASA

A short-term flight research program with one of the world's most unusual aircraft, the human-powered Gossamer Albatross will be funded jointly by Dryden Flight Research Center and the NASA Langley Research Center. They will study the flight characteristics of a light-weight, low-speed aircraft for possible application to future aircraft capable of flight at extreme altitudes.

The Gossamer Albatross No. 2 is one of several human-powered aircraft designed and built by Dr. Paul MacCready, president, AeroVironment Inc., Pasadena, Cal. The vehicle to be flown in the NASA program is the sister ship of the Gossamer Albatross No. 1 which made history by flying across the English Channel under human power last summer. The Gassamer aircraft are powered by the pilot who pedals a bicycle-like arrangement that drives the propeller.

Special emphasis of the study will be on utilizing a lightweight data system to measure aircraft stability, control and performance characteristics. The aircraft will be flown at Dryden using human power, towed (propeller-off) flight and later, an electric motor for steady-state conditions. The flight program will be conducted primarily by AeroVironment under a $65,000 NASA contract.



NASA to Study Pedal Power—Gossamer Albatross I is the strange contraption that flew the English Channel in the summer of 1979, its only power provided by the pilot who pedals a bicycle-like unit that drives the propellor. A sister ship will undergo tests at both the Langley and Dryden centers.

New Device Detects Cancer

An instrument that makes use of space technology is being evaluated as a detector of cancerous tumors in the human body. Developed at Langley Research Center, the device—called a microwave applicator—is being tested at the Eastern Virginia Medical School at Norfolk General Hospital, and also will be tested for use in the treatment of cancerous tissue by heating a tumor to destroy cancer cells. The device has demonstrated already that it can locate tumors in

14 known cancer patients and has even found a cancerous site in one patient that was undiscovered by conventional techniques.

The microwave applicator's prime advantages are that it does not emit radiation, is used outside the body and should become relatively inexpensive if mass-produced.

If the instrument proves itself after an extensive series of hospital and laboratory experiments it could become standard equipment in doctors' offices. Patients could be quickly and easily tested for many forms of cancer, just as they are tested routinely now for heart problems with an electrocardiogram machine.

The microwave instrument contains a sensitive radiometer that can measure temperature variations of less than 0.1 degree Celsius (0.2 degree Fahrenheit). Because cancerous tissues are hotter than surrounding normal tissue, they are thus detectable by the applicator. The applicator also can detect heat differences much deeper in the body than conventional infrared thermography, where techniques are limited to detecting tumors near the skin's surface.

The next step in proving the instrument will begin early in 1980 when researchers at the Norfolk Medical School and at the Medical College of Virginia in Richmond test the device's ability to treat cancer in large laboratory animals. The treatment method will involve microwave heating of a tumor area to destroy cancer cells. Temperatures higher than 42 C (107.6 F.) are considered lethal to cancerous tissue.

Tumors have a poorer vascular system (fewer blood vessels) as compared to healthy tissue and contain more fluid. Researchers believe that heat from the microwave system will heat a tumor faster than the surrounding tissue because of the higher moisture content and the tumor will stay hotter because there are fewer blood vessels to carry the heat away.

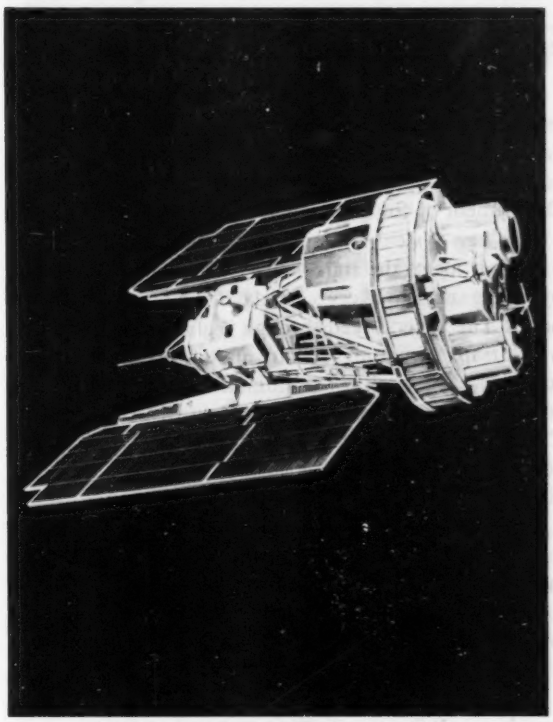
The project began when a Langley researcher suggested that microwave experts, who normally work on satellite communications and other space projects, should get involved in some way with using microwave techniques to detect and treat cancer. After preliminary research and development, Microwave Associates, Inc., of Burlington, Mass., which has worked with NASA for several years on aerospace projects, was asked to develop and build the instrument. Total funding to date, from the NASA Technology Utilization Program, has amounted to less than $47,000.

Landsat 2 Shows its Age

Landsat 2, the nation's second in a series of Earth orbiting satellites used to monitor the world's resources, shows signs of wearing out after almost five years of continuous service. The spacecraft, with a designed life expectancy of only one year, has been experiencing difficulty in its onboard attitude control mechanism.

Controllers at the Goddard Space Flight Center, believe that a rotating flywheel used to stabilize the spacecraft's yaw, or side-to-side motion, has become jammed due to degraded lubrication. The controllers have succeeded, since the problem was discovered on Nov. 5, in reorienting the spacecraft's solar panels toward the Sun. Now, power supplies are adequate for operations and the attitude can be maintained, thus allowing more time to free the jammed yaw control flywheel or attempt an alternate control procedure.

If Landsat 2 joins Landsat 1 (launched in 1972 and shut down in 1977) in retirement, Landsat 3 will remain as the sole Earth resources monitoring satellite in orbit until Landsat 4, the fourth and most advanced spacecraft in the series, is launched in late 1981.



Artist's conception of Landsat 2 orbiting.

There was hope that Landsat 2, despite its age, could provide supplemental worldwide coverage to Landsat 3 until late 1980. Landsat satellites weigh about 900 kilograms and orbit the Earth every 103 minutes, some 910 kilometers in space. Their remote sensing instruments send back images of Earth in 185-km strips running nearly north-to-south at an angle to the equator of 99 degrees. In this type of orbit, surface coverage of the Earth proceeds westward, with a slight overlap, so that the globe is covered every 18 days.

Landsat data has been used by scientists and local officials in the United States and more than 100 foreign countries for a wide variety of applications ranging from crop inventories to flood assessment and mineral exploration.

In addition to the three Landsat monitoring stations in the United States, seven foreign Landsat ground stations operate throughout the world with several more under construction and a number of others in the planning stages.

It is expected that these domestic and foreign ground stations will have the capability to receive, process, archive and disseminate Landsat 3 data on a global scale to partly offset the effect of the loss of Landsat 2.

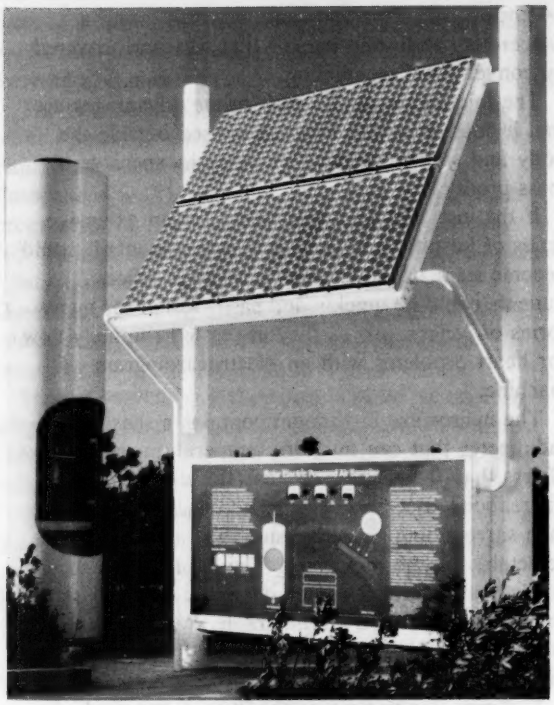
First Solar Electric Air Sampler Unveiled

The nation's first solar photovoltaic-powered air monitoring station was dedicated Nov. 20 by New Jersey Governor Brendan Byrne and representatives of the U.S. Department of Energy, the New Jersey Department of Environmental Protection and NASA.

The new system is designed to determine whether or not air meets the state and federal health standards by taking samples every sixth day for a period of 24 hours. The air is forced through a glass fiber filter which traps minute particulate matter. Filters are then removed each week for examination by the New Jersey Bureau of Air Pollution Control in Trenton. The new unit, in Liberty State Park, N.J., is the latest addition to a statewide network of more than 100 air sampling stations.

The heart of the new silently operating, non-polluting, 360-watt solar power station is its 8.9-square-meter array, consisting of 20 photovoltaic modules, a total of 860 individual silicon solar cells. The entire array is mounted on a 5.2-m tubular aluminum frame.

During the day, the station is totally powered by the photovoltaic system. Excess electrical energy



Solar air sampler now in operation.

produced by the system is stored in a bank of lead-acid batteries, specifically designed for solar electric use. Power is withdrawn from the batteries to run the station during the evening and early morning hours of its weekly 24-hour cycle.

Total cost of the project, funded jointly by the two state and federal departments, including the air monitoring equipment, the photovoltaic power unit, the display, design and installation, is $93,000.

The purpose of the Department of Energy photovoltaic program is to develop solar cell power systems which can provide a significant amount of the nation's electrical energy requirements by the year 2000. The project at Liberty State Park is one of several sponsored to stimulate early markets for solar photovoltaic power through cooperative cost-shared experiments with potential users. Additionally, this project displays to the general public the practical value of solar electric technology.

Solar photovoltaic systems have shown important economic gains in the past few years. The cost of solar-generated electricity was about $7 per kilowatt-hour (1980 dollars) in 1976; today, costs range from $1 to $2 per kilowatt-hour. The Department of Energy hopes to see that price drop to under 10 cents per kilowatt-hour in the late 1980s, at which time

electricity generated by the Sun will become competitive in many areas with more traditional power sources.

The solar power air monitoring system was produced under management of the NASA Lewis Research Center as part of the Department of Energy's National Photovoltaic Convention Program. More than 20 solar photovoltaic power systems designed by NASA Lewis are in operation in the United States and overseas providing electricity for diverse applications such as isolated villages, forest lookout towers and weather stations. In remote areas of the world, photovoltaic systems already are competitive in cost with alternative power sources, such as diesel generators.

Donald Beattie, Director of NASA's Energy Systems Division, commented: "This is just one of the many cooperative efforts with the Department of Energy and NASA is proud to have the opportunity to work with industry, state and local officials to bring this viable renewable energy source into a 'real world' application."

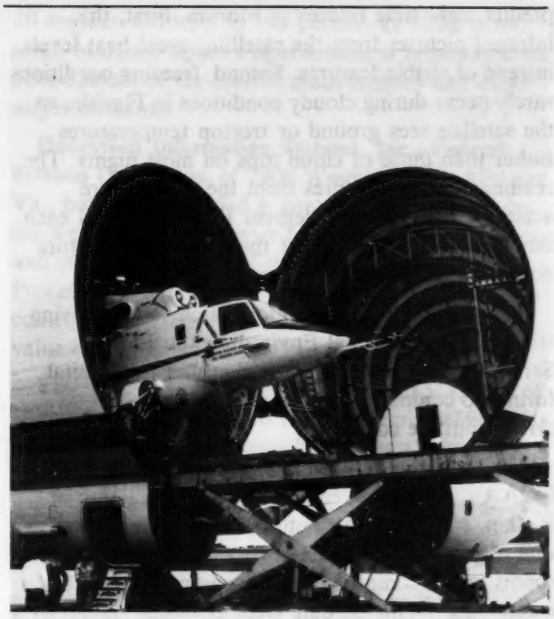
Weather Eye from Space

Forecasting a cold snap, how cold it will be and for how long, and when and where it will occur is vital to Florida's multi-billion dollar agricultural industry. Failure to turn on wind machines, fire up citrus grove heaters or take other measures can mean the loss of an entire crop. On the other hand, the costs of standing by to perform these functions runs up to $43,000 per hour for the citrus industry alone, and the expense of using all protective means can hit $6 million for each night of operation. Guessing either way isn't good enough.

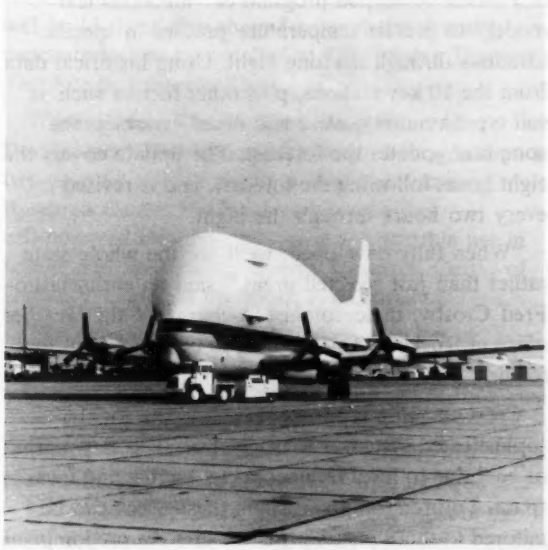
The growers need the answers. For the past several years, they have come from space, and the system is being improved. Entering the payoff stage is a project by the National Weather Service, the University of Florida and Kennedy Space Center to develop a computerized forecast ability for freeze conditions.

The eyes of the system is the National Oceanic and Atmospheric Administration's (NOAA) weather satellite with a formal name of Geostationary Orbiting Environmental Satellite 1, which is in a stationary orbit 35,000 kilometers over the equator in a position above Colombia, South America.

The satellite provides forecasters with both regular photographs and infrared pictures every 30 minutes. Two aspects of the photos allow the weathermen to



Taking the Guppy—Rotor System Research Aircraft (RSRA) Number One disappears into the maw of the NASA Super Guppy after flight tests at the Wallops center and the giant transport plane readies for the trip back to Ames Research Center. RSRA Number One flew at Wallops in the winged compund configuration. Aircraft Two, which flew at Wallops in a pure helicoptor configuration, left for Ames aboard the Super Guppy earlier this year. The two research aircraft, nicknamed "Heathcliff" and "Gertrude" respectively by their Sikorsky manufacturer, are heavily instrumented and can accommodate a variety of different rotor systems for testing as a hybrid copter-airplane.



predict night-time freezes in Florida. First, the infrared pictures from the satellite reveal heat levels instead of visible features. Second, freezing conditions rarely occur during cloudy conditions in Florida, so the satellite sees ground or treetop temperatures rather than those of cloud tops on most nights. The readings of temperatures from the satellite are accurate to within two degrees Fahrenheit and each tiny element or "pixel," of the transmitted picture covers an area about 8 km on a side.

The satellite beams its information to a receiving station at the National Environmental Satellite Service in Suitland, Md. It is then fed in a digital format to computer complexes in field stations throughout the country.

The station of interest to Florida agriculture is NOAA's National Weather Service installation at Ruskin. NASA's contribution to the system, besides that of originally launching the satellite, is a highly sophisticated computer and image analyzer which transforms the digital data from electrical signals to a multi-color display of temperature profiles.

Each color in the television map represents a specific temperature range, giving forecasters an accurate picture of the advancing cold air. The satellite data, plus reports from field locations, allow forecasters to present a much more accurate and detailed summary of what is occurring across the state. To predict what will continue to occur, over as much as eight hours, the computer uses a University of Florida developed program or "mathematical model" to predict temperature profiles in specific locations through the long night. Using historical data from the 10 key stations, plus other factors such as soil type, humidity, wind and other variables, the computer updates the forecast. The update covers the eight hours following the forecast, and is revised every two hours through the night.

"When fully developed, we'll see the whole state rather than just selected areas," said an enthusiastic Fred Crosby, meteorologist-in-charge of the weather office at Ruskin. "This is going to be a powerful tool for us."

Crop planning is another possible use for the sophisticated system. Areas which tend to stay warm or cool due to local influences can be mapped from space. Future crop plantings in these areas can be tailored to those plants which require the predominant temperature profiles of the area.

In Strictest Confidence—Dr. Jeanne Richmond, who recently began work as a part time counseling psychologist at the Marshall center, exercises extreme care in her dealings with employees. The secretary who answers her telephone does not ask the caller's name; Dr. Richmond does not leave her name on a return call and doesn't even keep notes for her own records. "For obvious reasons, we feel this confidentiality is necessary", Dr. Richmond says, "I am the only person at the Marshall center who knows my clients or what problems they have." She has been in counseling and psychology for more than 20 years and holds four degrees from three universities.

TMI Commission Honors Ten from NASA

The President's Commission on the Accident at Three Mile Island was created by President Carter's Executive Order 12130 on April 11, 1979, and was charged with conducting a comprehensive study and investigation of the accident involving the nuclear facility and making recommendations based on its findings. Dr. John Kemeny, president of Dartmouth College was appointed chairman of the twelve member commission. On October 30, 1979 the commission presented their report to the President. The report, along with 10 volumes of legal and technical staff reports, represent the finding of more than two hundred experts, consultants and government employees engaged in the investigation.

On November 15, Dr. Kemeny conducted an

awards ceremony to honor the participants. The following NASA employees received Presidential Commission Awards:

Vincent L. Johnson-NASA Headquarters—Distinguished Service Award; Leonard Jaffe-Headquarters—Exceptional Service Award; William M. Bland, Jr.-Johnson Space Flight Center—Exceptional Service Award; Robert English-Lewis Research Center—Certificate of Appreciation; A. Virginia Barnes-Headquarters—Certificate of Appreciation; Dwight Reilly-Lewis Research Center—Sustained Superior Performance Award; Francis T. Hoban-Headquarters—Exceptional Service Award; Fred Bowen-Langley Research Center-Exceptional Service Award; Richard Sprince-Headquarters—Certificate of Appreciation. Mary Woolard-Headquarters—Letter of Appreciation. The President's Commission was terminated in December.

JSC Executive Honored in Washington—Dr. James E. O'Neill, left, Acting Archivist of the United States, presents the Award for Excellence of the Association of Records Managers and Administrators to Robert R. Regelbrugge, chief of the Institutional Support Development Branch, Johnson Space Center; Col. Lawrence W. Vogel, NASA Headquarters Administration Director looks on. Regelbrugge was honored for his development of the Interactive Basic Accounting System, now a fixture at JSC.

Contractor News

Rocketdyne Division of Rockwell International Corp., of Canoga Park, Calif., has finalized with NASA the issuance of a $365.7 million amendment to an original 1972 contract to build Space Shuttle main engines. The amendment authorizes Rocketdyne to proceed with the manufacture and testing of 12 additional main engines, as well as the overhaul of 10 engines and tests to 109 percent of rated power level. Marshall Space Flight Center is responsible for development of the Shuttle main engines and other major elements.

Honeywell Information Systems, Inc., Federal Systems Operations, of 7900 Westpark Ave., McLean, Va., has been awarded a contract modification by the Kennedy Space Center for continued maintenance and software support of the Space Shuttle Launch Processing System's data subsystem in KSC's launch control center. The new award brings the aggregate value of the parent contract to $56 million plus.

The Vought Corp., a subsidiary of LTV Corp., of Dallas, Tex., has received two contract modifications from NASA for Scout launch vehicles and support services. One modification calls for Vought to build five Scout vehicles and five payload heatshields. The work, to be performed in Dallas, is valued at just under $4.3 million. The second modification, valued at approximately $16 million, is a two-year extension of work involving systems management, reliability and quality assurance, vehicle processing and launch and logistics support services through 1981. The Scout, NASA's smallest launch vehicle, is managed by the Langley center.

General Electric Company's Space Division, of Valley Forge, Pa., has been awarded a 16-month $1.2 million contract by the Jet Propulsion Laboratory for DoE to design and build prototype units for solar energy to provide electrical power to small communities and rural areas. Under the contract, GE will build three dish-shaped solar thermal energy concentrators to be installed at JPL's Solar Thermal Test Site at Edwards, Calif.

Westinghouse Electric Corp. Research and Development Division, of Pittsburgh, has agreed on a two-year $4 million contract with the Lewis Research Center for development of a fuel cell-powered total energy system for possible use in homes and apartments. Energy Research Corp., of Danbury, Conn., is the major subcontractor.

The Hampton Technical Center, division of Kentron International, Inc., of Dallas, Tex., has been selected to provide technical support work for research and development programs at the Langley Research Center. The two-year agreement is a continuation of previous contracts with Kentron and is valued at approximately $24 million. Most of the work will be done at the Hampton Technical Center with certain special tasks performed at Langley.

Did You Know?

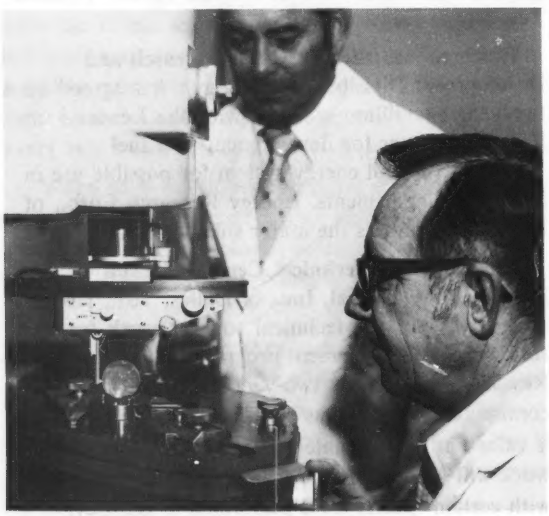
Idea Clearinghouse, now a going concern, was established in the fall to disseminate proven good ideas throughout the agency. One of the first ideas accepted was modernization of the drive unit on Monarch lathes, developed by the Ames Research Center. Ames personnel worked for six months to modernize "EE" Monarch lathes that were scheduled for replacement, at a significant savings to the center. Ideas and innovations should be cleared through the Headquarters Information Systems Division, NSM-12.

KSC Bus Tours, following a decline of four consecutive months, picked up in the last quarter of 1979. Tour patronage through May of last year had been proceeding at a record pace as the Kennedy center continued its buildup for the first manned orbital flight of the Space Shuttle, then dropped sharply with nationwide gasoline shortages. In October, guided bus tours of the Spaceport and the Cape Canaveral Air Force Station attracted 64,437 visitors, up 2.3 percent over the same month in 1978.

The Goddard Photographic Section has been named Department of the Year (Engineering Category) by the Professional Photographers Association and the Eastman Kodak Company for its design in providing on-the-spot records of maps and census data. The GSFC shop developed a method of rapidly and accurately photographing computer graphics drawn on video-display terminals.

The Navajo Division of Resources successfully demonstrated their automated resource inventory system to some 25 tribal officials in Tsaile, Arizona. In 1977, the Navajo Tribe began a joint project with NASA to utilize information from Landsat satellites on soils, topography, rainfall and vegetative cover. NSTL's Earth Resources Laboratory has worked with the Navajo for the past two years.

The National Secretaries Association announced the results of its grueling two-day certification examination and Gretchen Evans, graduate of GSFC's Certified Professional Secretary Training Program, was the only Maryland resident to pass the exam; another graduate of the Goddard program, Teresa Ricketts, was among the 10.6 percent nationwide who passed the initial testing. The training course for secretaries began with an incentive program established by the Goddard center in 1976.



The Relativity of Roundness—The new device is called an Ultra-High-Precision Roundness Measurement System and it can determine the sphericity (roundness) of an object to an accuracy of .005 of a micro-meter. Jack Reed (foreground) and Roy Taylor of the Marshall center are shown measuring a small quartz ball which turns out to have a diameter of exactly .038 meters. The system is used primarily to measure spericity of rotors for gyroscopes for Gravitational Probe B (GP-B) which may be launched from the Space Shuttle in the mid-1980s. In Earth orbit, the GP-B would measure the minute precession, or change of axis, which Einstein's theory of relativity says will occur in a spinning body, such as a planet or gyro, revolving about a large mass.

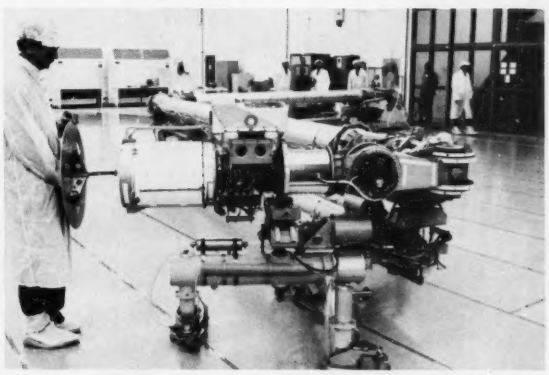
Patents for Inventions from NASA Research

The Office of General Counsel, NASA Headquarters, announces that the following U.S. patents have been issued by the U.S. Patent Office to NASA for inventions resulting from NASA research. Inquiries concerning them should be directed to the attention of the NASA Patent Counsel of the indicated installation.

Inventor(s) and Employer	*Title*	*Patent No.*	*Installation*
Arthur A. Rudmann, GSFC	Coupling device for moving vehicles	4,173,324	GSFC
John G. Simpson, MSFC	An improved solar concentrator	4,173,397	MSFC
Robert L. Mueller Robert K. Yasui, Caltech/JPL Pasadena, Cal.	Solar array strip and a method for forming the same	4,173,820	NRO/JPL
Robert P. Gruber, LeRC	Self-reconfiguring solar cell system	4,175,249	LeRC
Eldon Jeffers Richard R. Thomas, Boeing Aerospace Company, Houston, Tex.	Method and apparatus for eliminating luminol interference material	4,176,007	MSC
William A. Leary, GSFC Charles R. Griffin	Antenna deployment mechanism	4,176,360	GSFC

Launches for 1980

Name	Launch Date	Vehicle	Range	Mission Remarks
FLTSATCOM-C	January	Atlas Centaur	ETR	DOD Navy. Reimbursable
SMM-A	January	Delta	ETR	NASA. Scientific Solar Maximum Mission.
Intelsat V-A	February	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
NOAA-B	April	Atlas-F	WTR	NOAA Weather. Reimbursable.
Intelsat V-B	May	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
Navy-20	July	Scout	WTR	DOD Transit. Reimbursable.
GOES-D	August	Delta	ETR	NOAA Weather. Reimbursable.
Intelsat V-C	August	Atlas Centaur	ETR	Intelsat communications. Reimbursable.
Navy-21	October	Scout	ETR	DOD Transit. Reimbursable.



Shuttle's Canadian Connection—The Remote Manipulator System, nearing completion in Toronto, will provide the Shuttle orbiter with its space "arm". Designed and built by Spar Aerospace, Limited, the assembly will have the dexterity to deploy or retrieve a variety of payloads in space flight.

Remote Manipulator's "Office"—Operator Complex is a replica of the control station for simulation purposes that will be the aft flight deck of the Shuttle orbiter. Simulated view of the cargo bay and payload (on TV monitor) is seen from the cargo bay aft bulkhead over a closed circuit (CCTV) television system.

Another Dividend from Air and Space

Research and development in aeronautics and space have provided numerous benefits for all Americans—and at a tiny percentage of the tax dollar. Here is an example:

Silent Partner in Cardiology

Education of medical students in cardiology requires access to patients having a variety of different forms of heart disease. But bringing together student, instructor and patient is a difficult and expensive process that does not benefit the patient. An alternate approach is substitution of a lifelike mannequin capable of simulating many conditions of heart disease. The mannequin pictured below, together with a related information display, is an advanced medical training system whose development benefited from NASA visual display technology and consultative input from NASA's Kennedy Space Center.

The mannequin system represents more than 10 years of development effort by Dr. Michael S. Gordon, professor of cardiology at the University of Miami (Florida) School of Medicine. Dr. Gordon was assisted by colleagues at the medical school, by the New York firm of Messmore & Damon which builds the mannequins, and by NASA's Biomedical Applications Team, Research Triangle Institute, North Carolina

The electronic mannequin simulates 40 heart disease conditions with a high degree of realism, for example, chest movement, pressure in artificial veins and arteries, and sounds of heartbeat rhythms. On the accompanying display unit, the instructor or student can push buttons to call up such information as patient histories, electrocardiograms, x-rays, blood circulation data and responses to medical and surgical treatments. The mannequin has proved a valuable educational aid at the University of Miami, Duke University Medical School, Yale University Medical School and the American College of Cardiology. The system is being produced commercially by Messmore & Damon.*

NASA

National Aeronautics and Space Administration

"For the benefit of all . . ."

* NASA does not endorse commercial products developed as a result of its Technology Utilization or Patent Licensing Programs, but it does encourage the widest possible use of its technology.